Saskatchewan
Parks and
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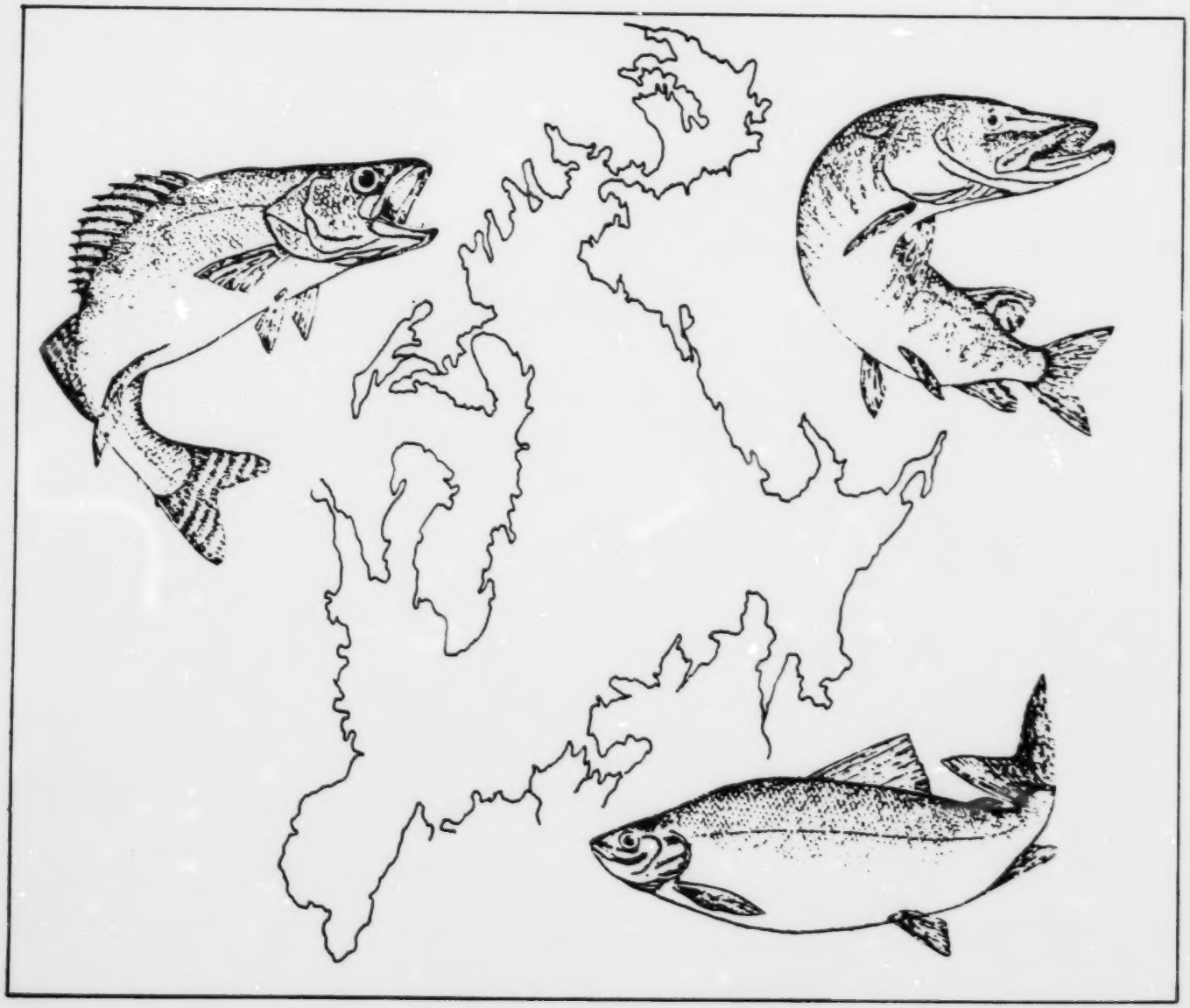
Resources

Northern Lakes Fish Monitoring Program:

Jan Lake - 1989

Technical Report 90 - 2



NORTHERN LAKES FISH MONITORING PROGRAM

JAN LAKE - 1989

by

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FISHERIES TECHNICAL REPORT 90-2

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EXECUTIVE SUMMARY

A fisheries investigation was carried out on Jan Lake during the summer of 1989 for the purpose of evaluating the current status of the resource. This report deals with the results from that investigation and compares them to results obtained from a similar study conducted in 1963-64.

Jan Lake is situated in northeastern Saskatchewan, approximately 80 km east of Flin Flon, Manitoba, near the southern border of the Precambrian Shield. It has an area of 11 346 hectares, a maximum depth of 32.5 m and a mean depth of 8 m. The lake has a limited drainage with no major inlets. It receives water from 21 small streams.

Seven species of fish were caught in 10 gillnet sets. Ciscoes and common white suckers were the two most abundant species, comprising 37% and 18%, respectively, of the total catch. Northern pike made up 13% of the total catch followed by lake whitefish (12%) and walleye (9%). Yellow perch and burbot made up the remaining 11%. Based on the number of each species caught per net set, fish stocks in Jan Lake have increased since 1963-64.

The majority of lake whitefish caught were over 35 cm in fork length. Ages ranged from 1-12 years, with 70% of the catch falling into the 6-8 year age range. Sexual maturity occurred between 5-6 years of age. Compared to the earlier study, the current population is

characterized by slower growth, later maturity, and an increase in the number of older and larger fish present.

Northern pike was the most abundant gamefish species in Jan Lake. Sizes ranged from 26 cm to 83.8 cm in fork length, with the majority between 50-60 cm. Ages ranged from 1-10 years with over 50% of the catch being 4-5 years of age.

The majority of walleye caught in gill nets were larger than 35 cm in fork length. Ages ranged from 1-12 years, with 48% of the catch falling into the 4-6 year age classes.

Pike and walleye abundance was probably underestimated by the test net catch as only 20% of the netting effort was conducted in the 65% of the lake covering an area of depths preferred by these species. The presence of numerous year classes, a high proportion of young fish and a relatively late age at maturation exhibited by both populations, however, indicates that walleye and pike stocks are strong.

There has been a commercial fishery on Jan Lake since 1930. Commercial harvest records for Jan Lake prior to 1964 include those fish caught in the southern arm of Pelican Lake, and are therefore inaccurate. Throughout the 1970's and 80's, the average annual harvest (4400 kg) was well below the allowable catch of 9100 kg.

Between 1986 and 1989, the average annual harvest from Indian permits was estimated to be 0.42 kg/ha. Half of this was comprised of fish species other than pike, walleye and whitefish.

The recreational fishery places the heaviest demand on the fish resources of Jan Lake. In the last 6 years, the estimated harvest was 6.18 kg/ha/yr (70 200 kg/yr), comprised of 50% northern pike and 50% walleye.

Maximum sustainable yield (MSY), derived using three standard methods, estimated 22 400 kg for pike, 7500 kg for whitefish and 4400 kg for walleye. Based on a comparison of harvest records and population statistics, the estimates for pike and walleye are low.

The study concludes the following:

1. Lake whitefish stocks in Jan Lake are being underutilized and could support a more active commercial fishery.

2. Northern pike and walleye populations are currently strong but are probably at or near their maximum allocation.

3. Estimates of MSY using the morphoedaphic index and bottom fauna were not adequate for Jan Lake stocks.

Recommendations, based on the findings of this report include the following:

1. Encourage the growth of the commercial whitefish fishery on Jan Lake.

2. Retain the commercial quota of 9100 kg. As it is currently not being met, changing it will not have any significant effect on the fishery.

3. Retain the 11.4 cm legal mesh size for commercial fishing. Increasing the mesh size would only result in catching larger fish, but not necessarily more fish.

4. Maintain harvests of the gamefish resource at the current level.

5. Monitor resident fish populations regularly to detect changes in population structure.

6. Sample all depth zones within the lake in future studies, to obtain a more representative sample of all fish populations.

7. Standardize a method for determining maximum sustainable yield for lakes throughout the province.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

Jan Lake was the subject of a fisheries investigation carried out from June 26 to July 12 in 1989. The study was conducted by the Saskatchewan Fisheries Laboratory, Fisheries Branch, Saskatchewan Parks and Renewable Resources. An earlier study in 1963-64 provided comparative baseline data for the present study.

Currently, Jan Lake supports 4 licensed outfitting camps, 4 campgrounds, 1 motel, and a cottage development; all of which are situated on the southeast corner of the lake. Recreational activities include canoeing, hunting, and fishing. A winter, as well as a summer, sport fishery exists on the lake, but has not been quantified.

A commercial fishery has existed on Jan Lake since 1930. At that time, a 22 700 kg/yr quota included lake whitefish, walleye, northern pike, and lake trout. The current quota of 9100 kg/yr was established in 1968 and in 1971, a 10% tolerance limit was imposed on gamefish species.

The primary objective of this study was to determine the status of the fishery resource in Jan Lake in relation to the previous study and to use the results as a basis for developing lake management strategies.

2. DESCRIPTION OF THE STUDY AREA

Jan Lake (54°56' 102°55') is located in east central Saskatchewan, approximately 80 km west of Flin Flon, Manitoba (Fig. 1). It is the southernmost member of a small, three lake chain including Mirond and Pelican lakes, and is one of the headwater lakes of the Saskatchewan River drainage basin (Johnson, 1967). It lies on the southern edge of the Precambrian Shield, and is underlain by metamorphosed igneous and sedimentary rock formations (Richards and Fung, 1969).

The drainage to Jan Lake is limited consisting of 21 small streams and no major inlets. The lake has a water area of approximately 11,400 hectares. Sixty-five percent of that covers depths less than 10 m while 35% covers greater depths (Table 1). The maximum recorded depth is 32.5 m and the mean depth is 8.0 m (Johnson, 1967). The presence of 241 islands scattered throughout the lake offer anglers protection from the wind. The total island area is approximately 1300 ha with 800 ha of that made up by the four largest islands: Harper, James, Busteed, and Schwitzer (Johnson, 1967).

Access to Jan Lake is provided by Hwy# 135, which runs northward from Hwy #106 96.5 km northeast of Prince Albert.

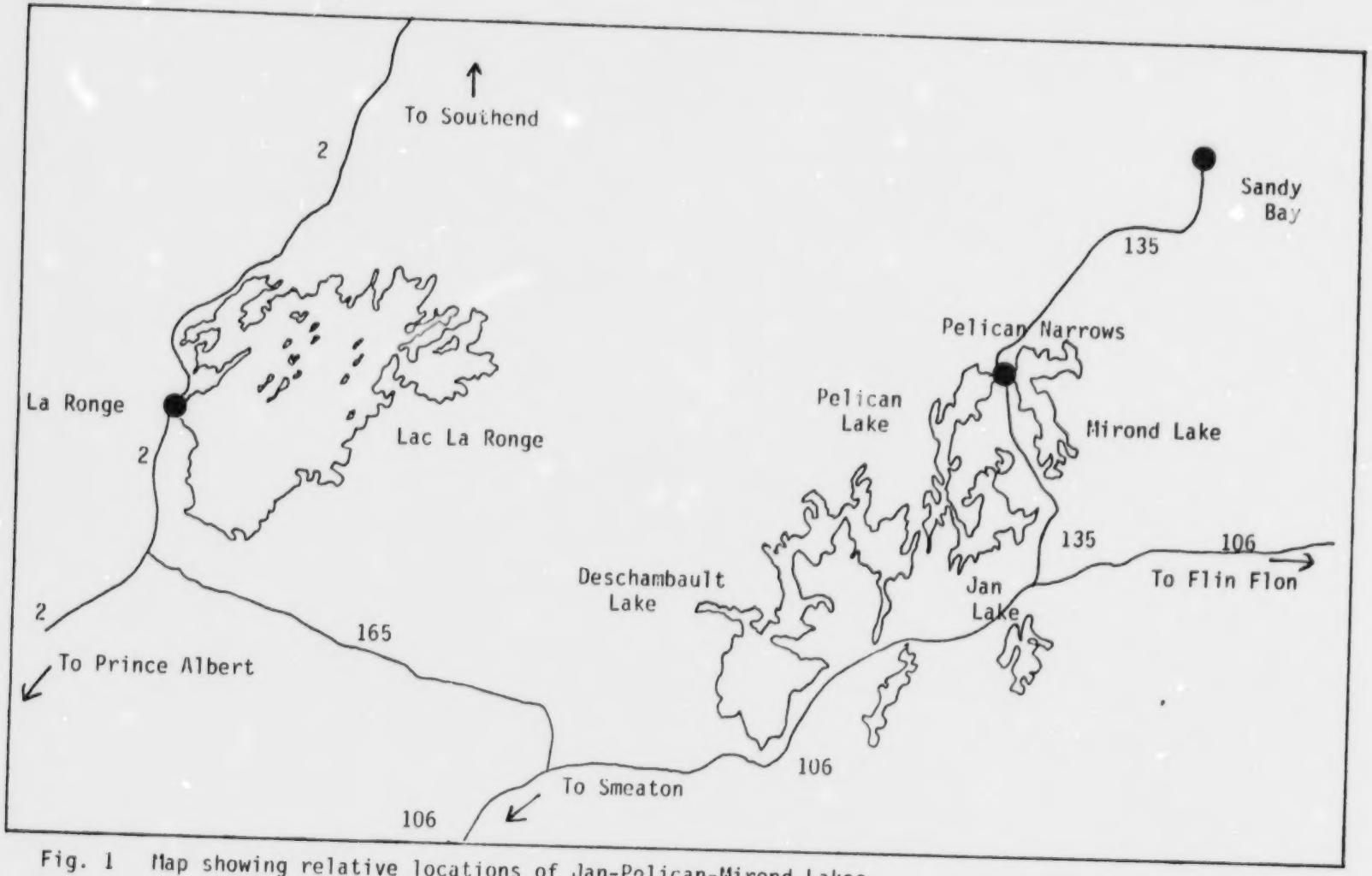

Fig. 1 Map showing relative locations of Jan-Pelican-Mirond Lakes.

Table 1. Distribution of depth zones within Jan Lake. (Adapted from Johnson, 1967).

Depth zone, m	Area		Lake volume	
	km^2	%	$x\ 10^8 m^3$	%
0-5	37.96	33.4	4.74	52.1
5-10	36.25	31.9	2.88	32.6
10-15	32.05	28.2	1.17	12.8
15-20	5.68	5.0	0.23	2.5
20-25	1.02	0.9	0.05	0.5
25-30	0.45	0.4	0.02	0.2
30-35	0.23	0.2	+	-
Total	113.65		9.10	

Mean depth, m	8.0
Maximum depth, m	32.5

3. METHODS

Fish were sampled using a standard gang of gillnet. The standard gang, 276 m in length with 46 m each of 3.8 cm, 5.1 cm, 7.6 cm, 10.2 cm, 12.7 cm, and 14.0 cm mesh size, has long been accepted as the standardized measure for assessing populations of large fish in Saskatchewan lakes. Ten standard gangs of gillnet were bottom set in Jan Lake in 1989. Each net remained set for approximately 24 hours after which time it was lifted and picked. An effort was made to place the nets in the same areas of the lake used by Johnson (1967) in 1963-64 (Fig. 2). Due to time constraints, however, it was not possible to duplicate the date of each net set.

Fish removed from the gill nets were classified according to species. Fork lengths (to the nearest millimeter) and weights (to the nearest gram) were recorded for all individuals of economically important species (i.e. walleye, lake whitefish, and northern pike). Sex and state of maturity were determined as male or female and immature, mature or, when possible, spent (post spawning). Stomach contents were inspected visually in the field. Other fish, including cisco, perch, suckers, and burbot, were counted and maximum and minimum lengths and total weights were recorded. Individual lengths and weights were recorded for a representative sample.

Aging media were taken from sufficient numbers of fish to provide a representative sample of fork lengths for each recreationally

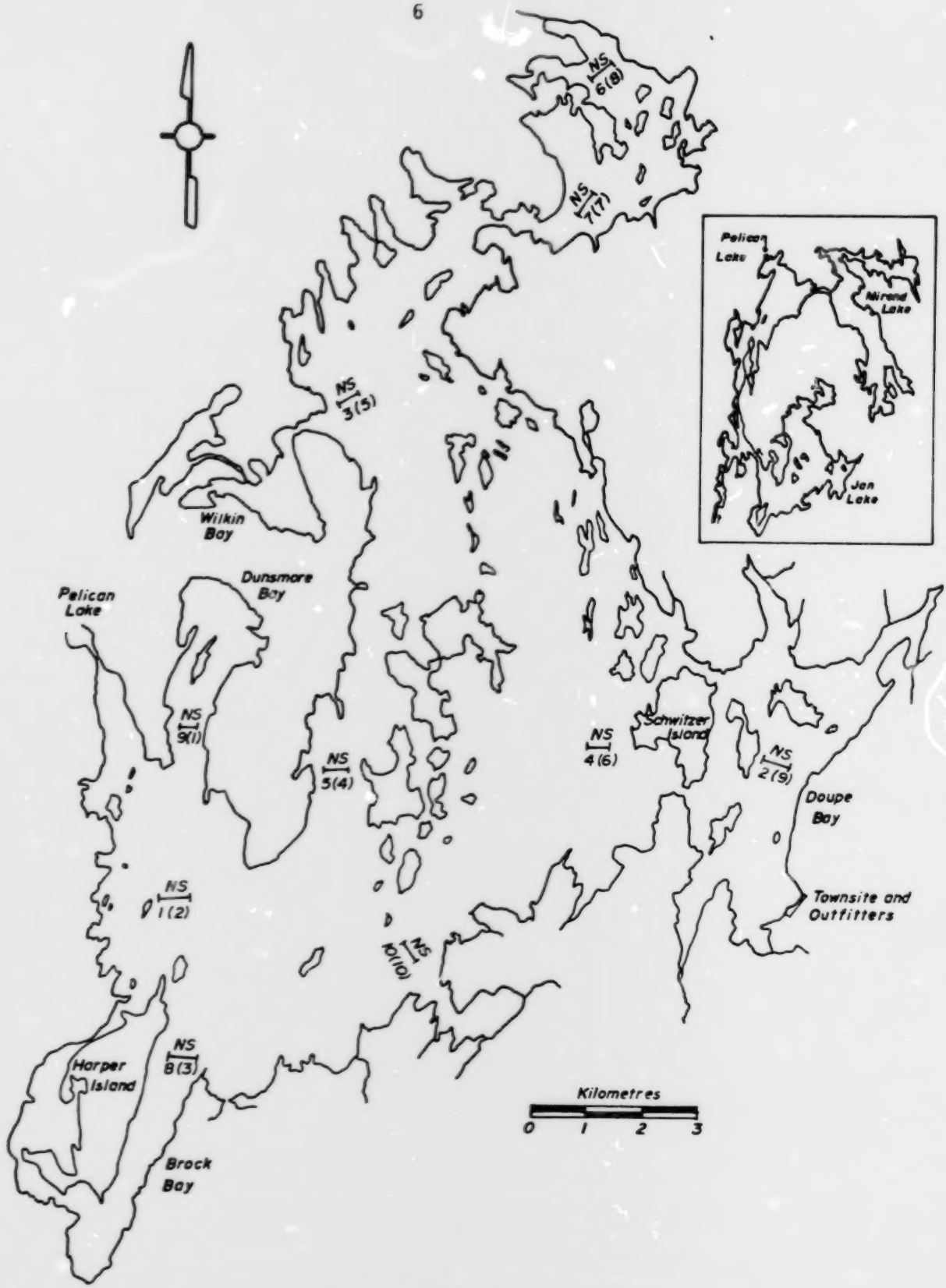

Fig. 2 Location of gillnet sets in Jan Lake in 1963-64 and 1989 (in brackets).

and economically significant species. In addition to scales, which were taken from all the fish, cleithra were taken from northern pike. Procedures used in the preparation and analysis of these media are described in Musker (1985).

4. RESULTS

Seven species of fish were taken in gill nets during the course of the 1963-64 and 1989 studies (Table 2). The average catch in Jan Lake showed an overall increase from 135.2 fish per standard gang of gill net in 1963-64 to 162.2 fish in 1989. Aside from cisco, which comprised 54% of the total catch in 1963-64 but only 37% of the total catch in 1989, numbers of each species caught per net set showed an increase between years.

While the total number of fish taken in gill nets in 1989 showed a 20% increase over that taken in 1963-64, the total weight increased by 63%, primarily as a result of a significant increase in productivity, particularly with regard to suckers and whitefish. In 1989, northern pike comprised the heaviest (36%) portion of the total catch. Common white suckers ranked second, providing 27% of the total weight and lake whitefish ranked third yielding 15%. Although more numerous than any other species, ciscoes contributed to only 11% of the catch by weight in 1989. Weight contribution to the total catch by burbot and yellow perch did not change significantly between studies. Ciscoes contributed the greatest weight for a single species (40%) in 1963-64, followed by northern pike (29%) and common white suckers (18%).

Table 2. Summary of fish species caught in 10 gillnet sets in Jan Lake in 1963-64 and 1989. (Wt=weight in grams)

Species	1963-64 No.	1963-64 Wt.	1989 No.	1989 Wt.
Common white sucker	190	120	286	356
Catostomus commersoni	(14)*	(18)	(18)	(27)
Cisco	735	269	605	144
Coregonus artedii	(54)	(40)	(37)	(11)
Lake whitefish	32	19	189	197
Coregonus clupeaformis	(2)	(3)	(12)	(15)
Northern pike	151	192	206	475
Esox lucius	(11)	(29)	(13)	(36)
Burbot	10	20	17	30
Lota lota	(.7)	(3)	(1)	(2)
Yellow perch	159	7	165	8
Perca flavescens	(12)	(1)	(10)	(1)
Walleye	75	41	154	94
Stizostedion vitreum	(5)	(6)	(9)	(7)
Total	1352	671	1622	1304
Average/net set	135.2	67.1	162.2	130.4

* Percentage of total catch for the year.

Walleye made up 6% of the total catch by weight, with lake whitefish, burbot, and yellow perch collectively contributing 7%.

Relative abundance of species changed slightly between years (Fig. 3). Ciscoes were the most numerous fish in both years, followed by the common white sucker. In 1989, northern pike ranked third, followed by lake whitefish, yellow perch, walleye, and lastly, burbot. In 1963-64, yellow perch ranked third, followed by northern pike, walleye, lake whitefish, and burbot.

LAKE WHITEFISH

A total of 189 lake whitefish were caught in gill nets in 1989; in 1963-64, only 32 were taken (Table 2). A comparison of the distribution of lake whitefish caught in various mesh sizes of gillnet is shown in Fig. 4. In 1989, the greatest number of lake whitefish were caught in the 10.2 cm mesh and were 35 cm or greater in fork length. Substantial numbers of larger fish were also caught in the 12.7 cm and 14.0 cm mesh sizes. In addition, there was a significant correlation between water depth and numbers caught ($r=0.65$, $p<0.05$). In 1989, 56% of the total whitefish catch was taken from nets set in water with a mean depth greater than 20 m. A total of 86% was taken in water exceeding 10 m in depth (Appendix 1).

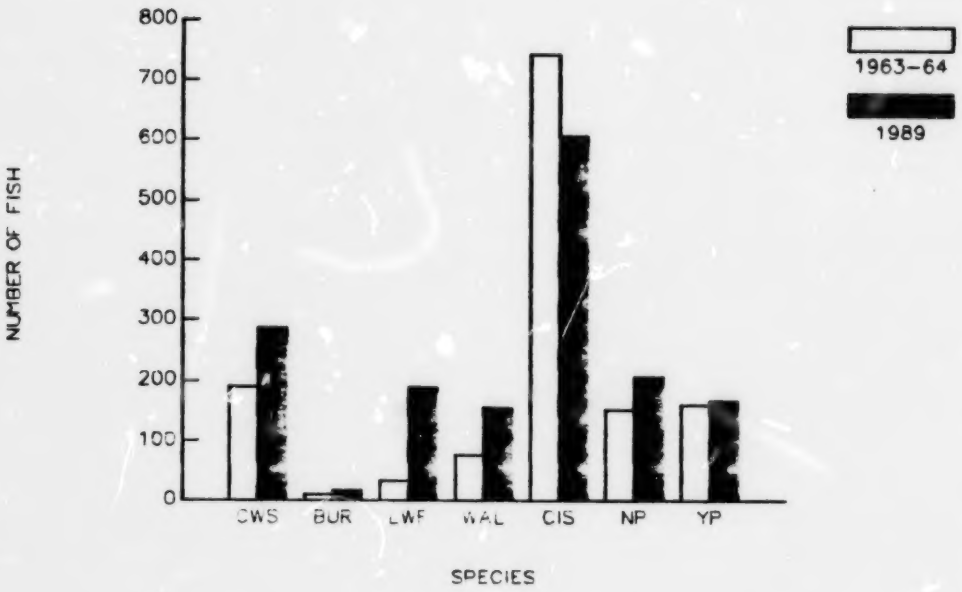

Fig. 3. Frequency distribution of fish species caught in 10 gillnet sets in Jan Lake in 1989 and 1963-64.

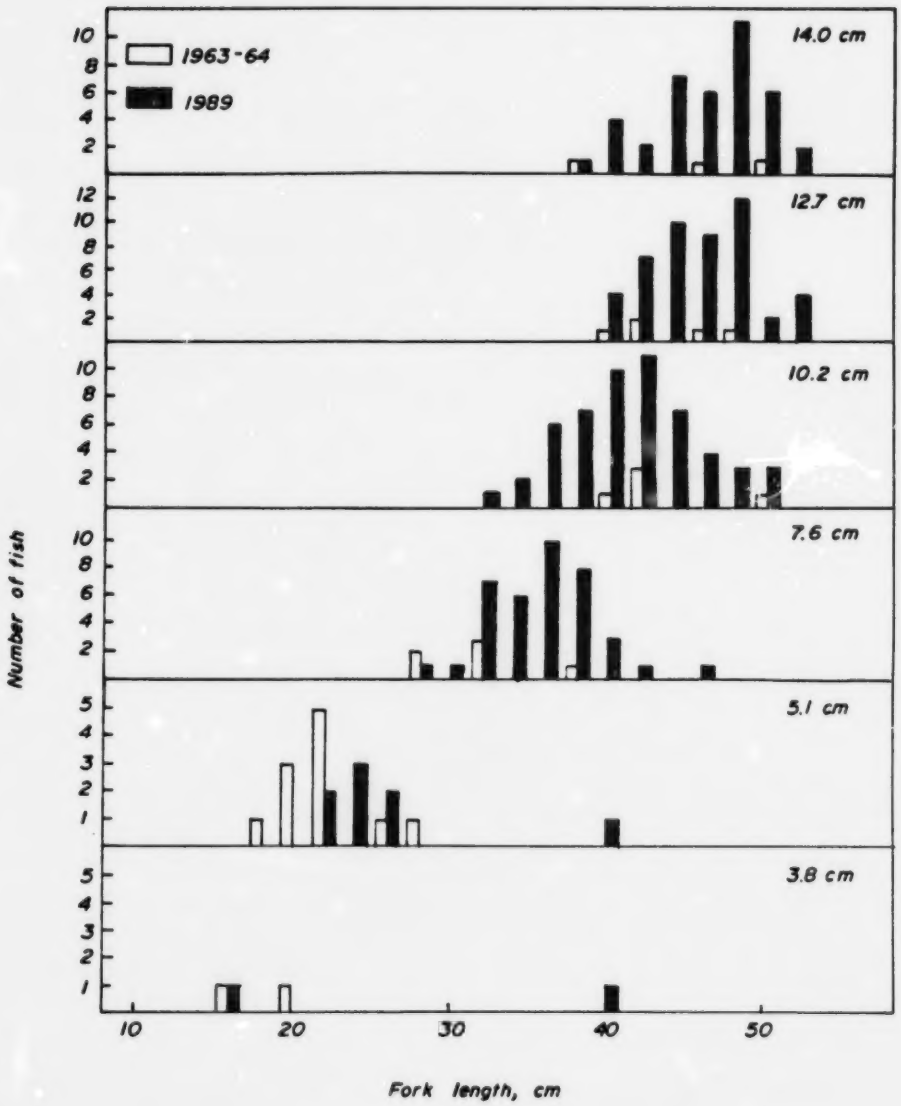

Fig. 4 Length frequency distribution of lake whitefish captured in various mesh sizes of gillnet in Jan Lake in 1963-64 and 1989.

The length frequency distribution of whitefish (Fig. 5) shows that fish caught in 1989 were longer in fork length than those taken in the earlier study. Fork lengths ranged from 14.7 cm to 49.3 cm in 1963-64, with a mean of 31.2 cm (Table 3) and from 14.2 cm to 51.7 cm with a mean of 40.5 cm in 1989. The average weight of fish taken in 1963-64 was 597 g, while those taken in 1989 had an average weight of 1073 g.

A comparison of weight-length relationshps of lake whitefish removed from gill nets in 1963-64 and 1989 is shown in Fig. 6. Up to 40 cm in fork length, fish taken in 1989 weighed slightly more per unit length than did those caught in the early study. Greater than 40 cm, however, the 1989 fish were more slender than their 1963-64 counterparts. Over 70% of the whitefish caught in 1989 exceeded 40 cm in length, suggesting that overpopulation resulting in a lack of food availability may be a critical factor regulating the population of this species.

The age composition and growth of lake whitefish are shown in Fig. 7. The distribution of ages in the present study shows a predominance of 7 year olds, followed, in order of abundance, by 8 and 6 year olds. Collectively, these three age classes made up 70% of the total whitefish catch. Very few younger fish were taken. Due to the small sample size from the 1963-64 data, not much can be said about the distribution of age classes in Jan Lake at that time.

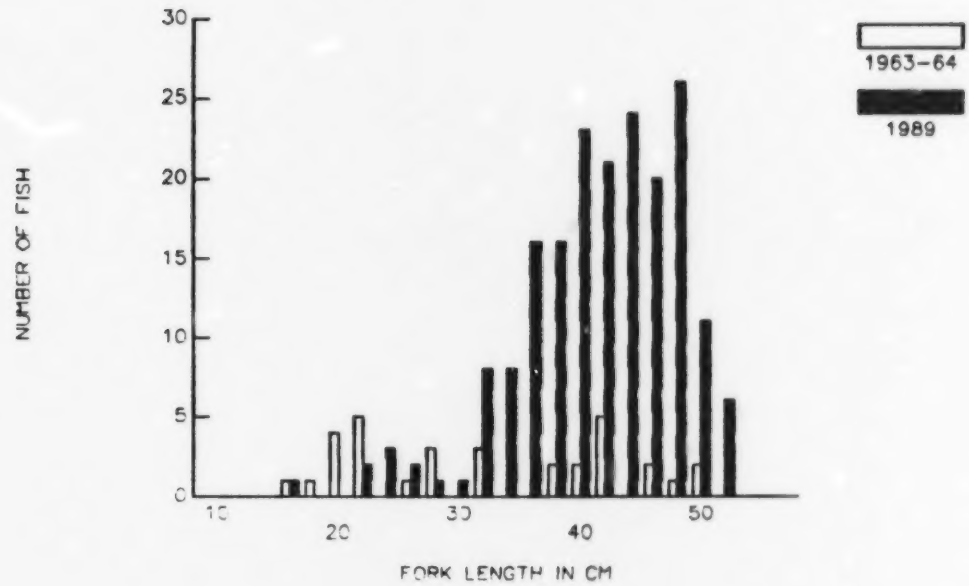

Fig. 5. Length frequency distribution of lake whitefish caught in 10 gillnet sets in Jan Lake in 1989 (n=189) and 1963-64 (n=32).

Table 3. Weight and length data for five fish species caught in 10 gillnet sets in Jan Lake in 1963-64 and 1989.

Species		1963-64 Length (cm)	1963-64 Weight (g)	1989 Length (cm)	1989 Weight (g)
Cisco	Mean	26.7	333.2	24.7	223.0
	Max	39.4	1106	37.3	850
	Min	13.0	28	13.3	30
Lake whitefish	Mean	31.3	597	40.5	1073
	Max	49.3	1860	51.7	2100
	Min	14.7	43	14.2	11
Northern pike	Mean	57.3	1292	54.7	1224
	Max	72.6	2722	83.8	4150
	Min	38.6	130	26.0	130
Yellow perch	Mean	14.8	45.9	15.1	46.7
	Max	21.3	128	21.0	130
	Min	11.7	26	12.7	30
Walleye	Mean	34.7	557	35.8	610
	Max	48.8	1219	58.4	2100
	Min	16.5	48	16.5	41

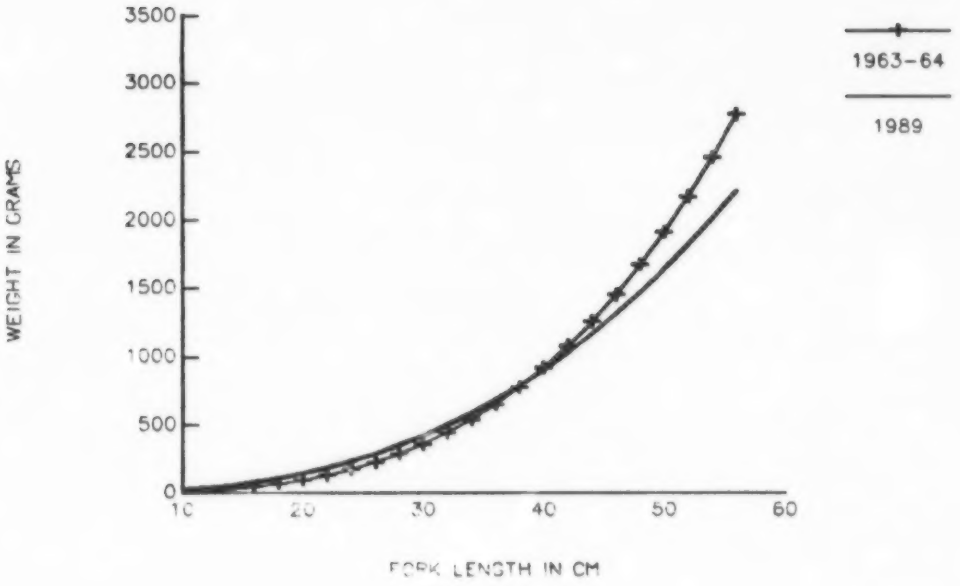

Fig. 6. Weight-length relationships of lake whitefish caught in 10 gillnet sets in Jan Lake in 1989 (n=189) and 1963-64 (n=32). (1989: $W=0.049421*L^{2.661048}$; 1963-64: $W=0.005138*L^{3.278937}$)

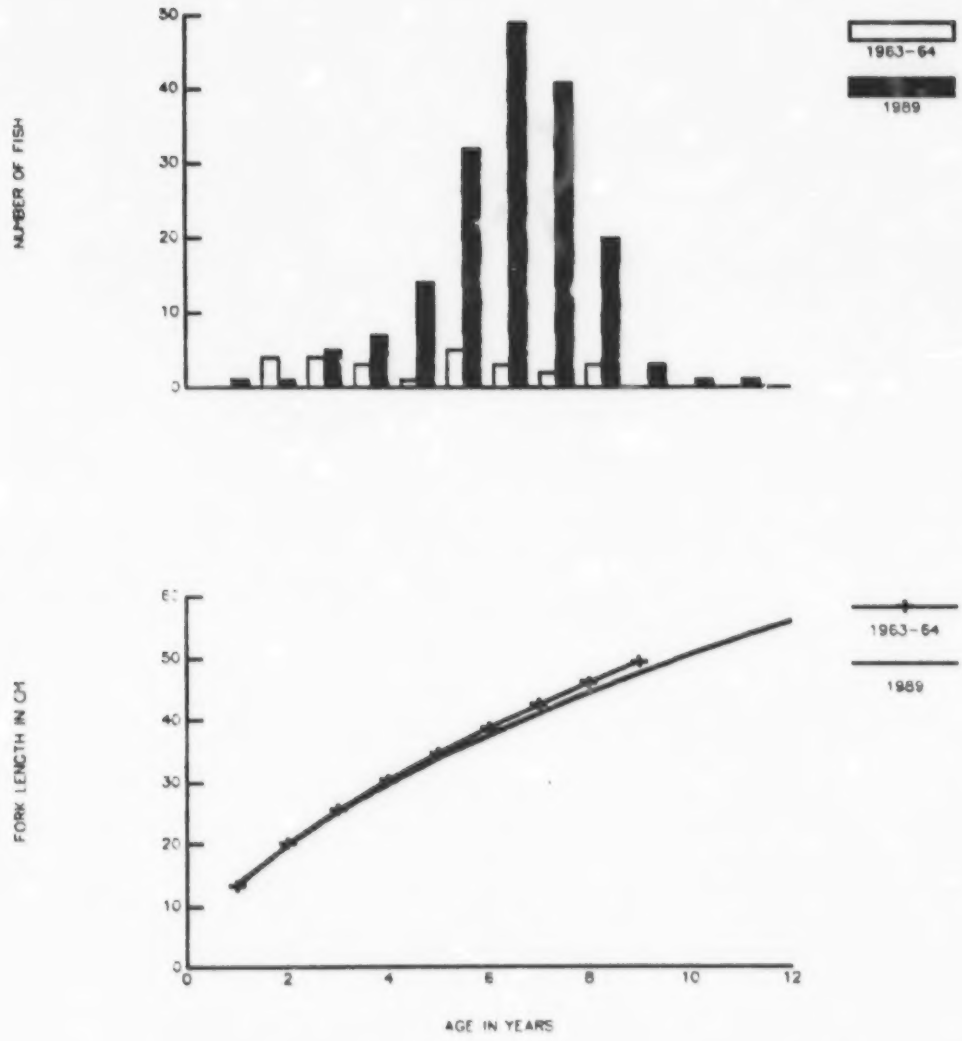

Fig. 7. Age distribution and growth of lake whitefish caught in 10 gillnet sets in Jan Lake in 1989 (n=175) and 1963-64 (n=25).

Growth rates of lake whitefish were similar between years. Growth was rapid in the first 3-4 years of life, after which it continued at a reduced rate. All fish 6 years of age (36.9 cm in fork length) and older were mature (Appendix 2). Only 12% of the 5 year olds were immature. Although it appears as though most fish in this population reach maturity by age 5, the small number of younger fish sampled preclude further statements with regard to age at maturity.

No quantitative data on the diet of lake whitefish in Jan Lake was acquired during the course of the study. A qualitative assessment showed that chironomid larvae (59% occurrence) were the major food items of this species. Similar results were reported by Johnson (1967). The second most popular food item was sphaeriid clams (24% occurrence). Other food items included mayflies, caddisflies, and plankton.

NORTHERN PIKE

The numbers of northern pike caught in gill nets in 1989 showed a 36% increase over those taken in the earlier study (Table 2). Because pike are not gilled so much as caught by their teeth in the net meshes (Johnson, 1967), size selectivity of mesh is not as crucial with this species as with others (e.g. whitefish). In 1989 however, the 7.6 cm mesh was the most effective in catching pike, yielding over 50% of the total catch; the majority of these ranging in size from 51 cm to 57 cm in fork length. Only large fish were caught in the 10.2 cm mesh.

The two larger mesh sizes (12.7 cm and 14.0 cm) yielded only 2 fish in 1963-64 and 4 in 1989. The number of pike caught was highly correlated with the mean water depth in which the net was set ($r=0.79$, $p<0.05$). Approximately 54% of the total catch was caught in nets set no deeper than a mean depth of 12.0 m. One third of the total catch was taken from water less than 10 m deep (Appendix 1).

The length frequency distribution of northern pike caught in gill nets in Jan Lake was similar in 1963-64 and 1989 (Fig. 8). A single mode in the distribution of the 1963-64 data occurs at 57 cm, representing a majority of 5 year olds. Modes in the distribution of the 1989 data occur at 53 cm and 59 cm and represent a majority of 4 and 5 year olds.

The current study yielded a wider range of fork lengths (26.0 cm to 83.8 cm) than did the earlier study (38.6 cm to 72.6 cm) but the overall mean lengths (57.3 cm and 54.7 cm, respectively) and weights (1292 g and 1224 g respectively) were similar in both years (Table 3).

A comparison of the relationships of weight to length for northern pike caught in Jan Lake in 1963-64 and 1989 is shown in Fig. 9, and shows that condition of pike sampled in 1989 was similar to that of those sampled in 1963. This suggests that conditions for pike survival in Jan Lake were not dissimilar between years.

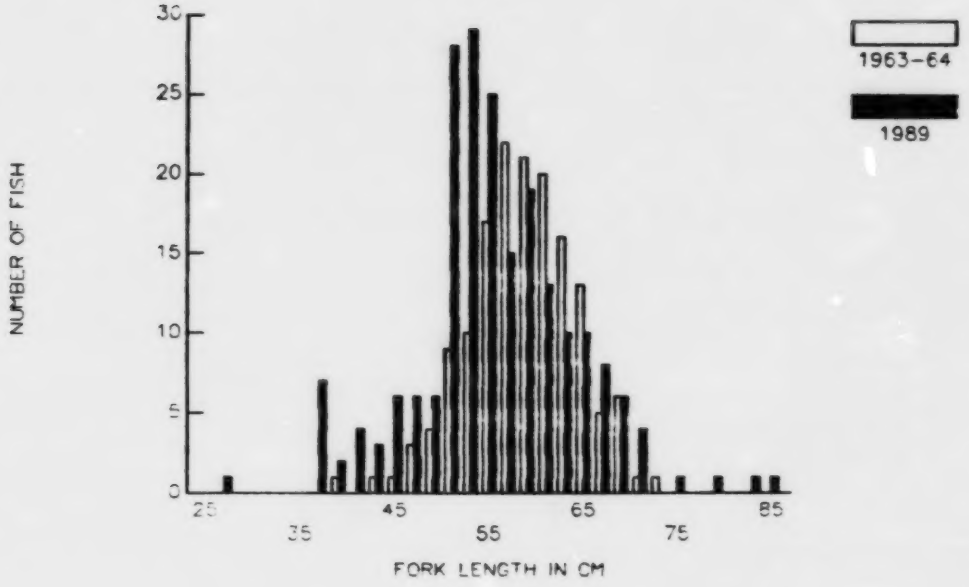

Fig. 8. Length frequency distribution of northern pike caught in 10 gillnet sets in Jan Lake in 1989 (n=206) and 1963-64 (n=151).

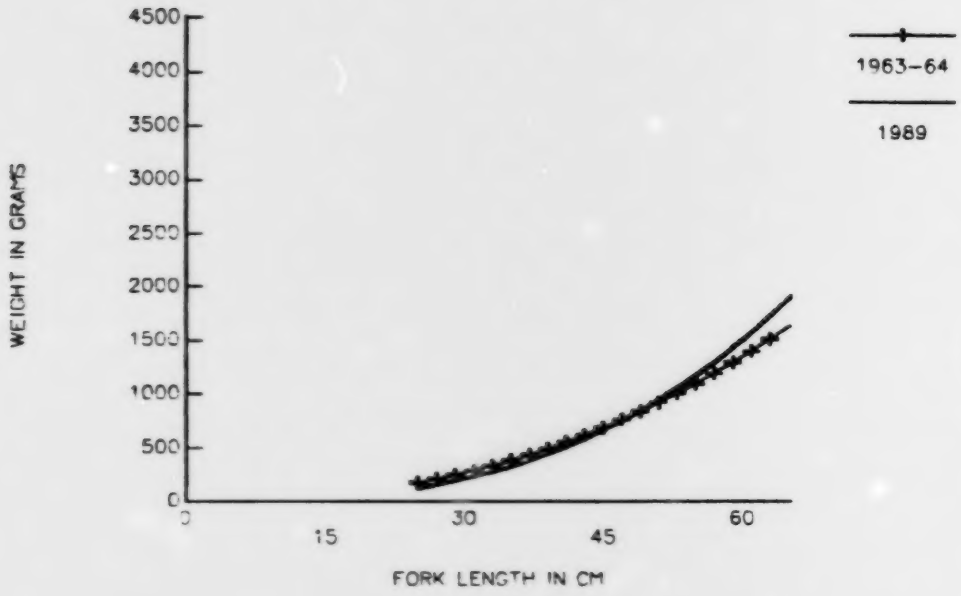

Fig. 9. Weight-length relationships of northern pike caught in 10 gillnet sets in Jan Lake in 1989 (n=206) and 1963-64 (n=151). (1989: $W=0.012589*L^{2.855656}$; 1963-64: $W=0.091325*L^{2.345367}$).

In 1963-64, ages for pike were estimated from scales. In 1989, both scales and cleithra were used to age pike, and gave similar results (Table 4). However, due to many scales being rendered useless by regenerated growth, pike were aged by cleithra in 1989.

Age composition and growth of northern pike in 1989 and 1963-64 are shown in Fig. 10. The age distribution of fish caught in 1989 covered age classes from 1-10 years, with 51% of fish falling into the 4 and 5 year age classes. The 1963-64 fish were estimated to be from 3-7 years of age, with the greatest portion (64%) of the catch also comprised of 4 and 5 year olds. The data show that growth rates of pike in 1989 and 1963-64 were very different. Pike from the current population exhibited very rapid growth in the first year of life. Fish older than 2 years of age were sexually mature (Appendix 3) and continued to grow at a much reduced rate. Fish collected in 1963-64 displayed a fairly constant, rapid rate of growth in all age classes. This could be a reflection of harvest pressure, wherein the 1963-64 population was subjected to heavier exploitation.

The diet of northern pike from Jan Lake was characteristic of this species from other lakes. Fish, primarily perch, comprised 83% of their diet in 1963-64 (Johnson, 1967). Only 32% of the stomachs sampled in 1989 contained food remains. Fish remains, including those of ciscoes, perch and suckers, occurred 80% of the time, while insects (Plecoptera) had a 20% frequency of occurrence.

Table 4. Comparison of ages determined from scales and cleithra collected from northern pike caught in gill nets in Jan Lake in 1989.

Scale age (y)	Mean cleithrum age (y)	Standard Deviation	Number cleithra
1	1	-	6
2	2.4	0.50	7
3	3.4	0.70	39
4	4.4	0.90	55
5	5.4	0.70	43
6	6.7	0.70	28
7	7.6	0.50	7

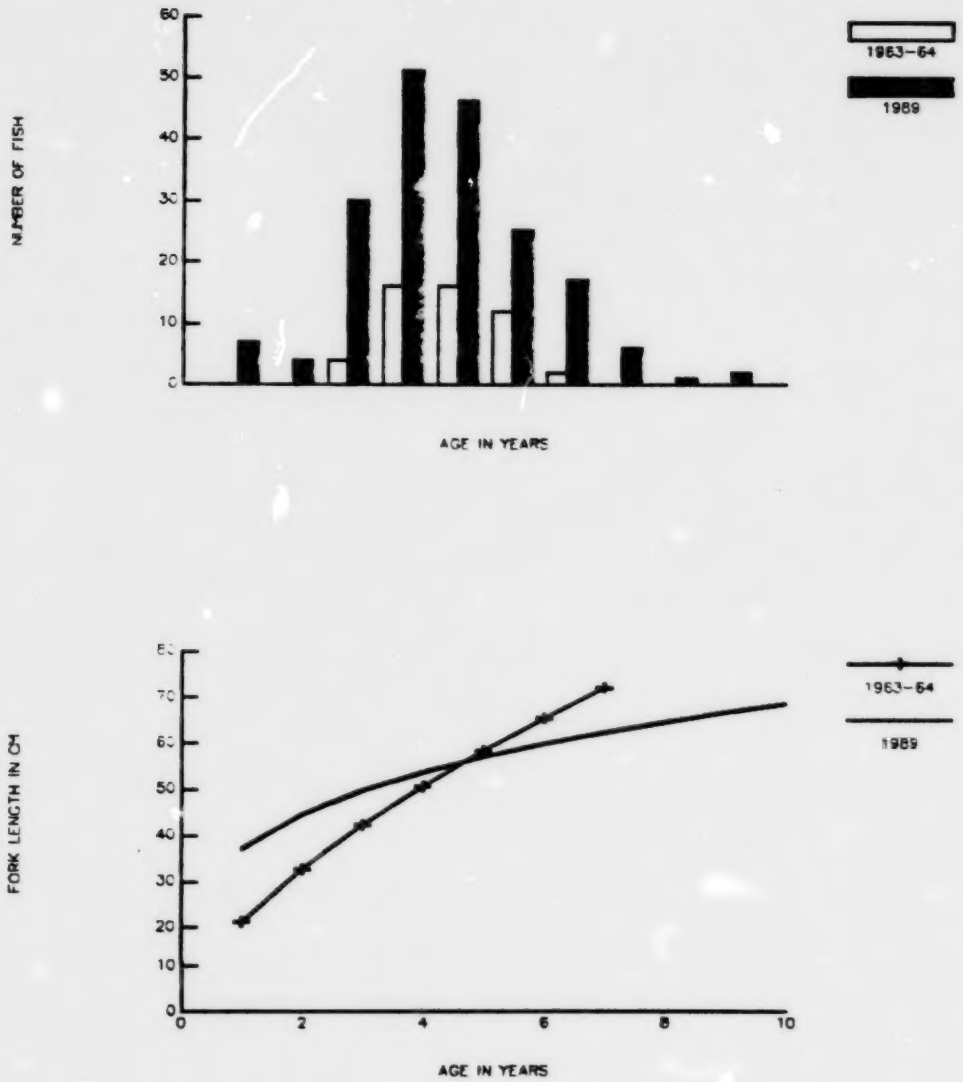

Fig. 10. Age distribution and growth of northern pike caught in 10 gillnet sets in Jan Lake in 1989 (n=189) and 1963–64 (n=50).

WALLEYE

Twice as many walleye were caught in gill nets in Jan Lake in 1989 than were caught in the earlier study conducted in 1963-64 (Table 2). There was a significant correlation between the number of walleye caught and water depth ($r=.66$, $p<0.05$). Over 50% of the catch was taken in water with a depth less than 10 m (Appendix 1).

In 1963-64 and 1989 walleye were effectively gilled in all mesh sizes of gillnet except for the 12.7 cm and 14.0 cm sizes. In 1989, the 5.1 cm mesh and the 7.6 cm mesh were the most efficient in catching walleye, yielding 60% of the total catch. These fish tended to be smaller than 39 cm in fork length.

The length frequency distribution for this species is shown in Fig. 11. Modal peaks for the 1963-64 study occurred at 23 cm, 33 cm, and 45 cm fork lengths and represented 3 year, 5-6 year, and 9 year age classes (Johnson, 1967). Peaks in the 1989 distribution occur at 19 cm, 23 cm, and 37 cm and represent 2, 3 and 6 year old fish.

In both years, the smallest fish caught had a fork length of 16.5 cm. In 1963-64, the largest fish taken was 48.8 cm in fork length while the largest caught in 1989 had a fork length of 58.4 cm. Mean lengths were similar for both years (Table 3).

Weight per unit length of walleye was not different between years (Fig. 12), which suggests that growing conditions for these fish were similar.

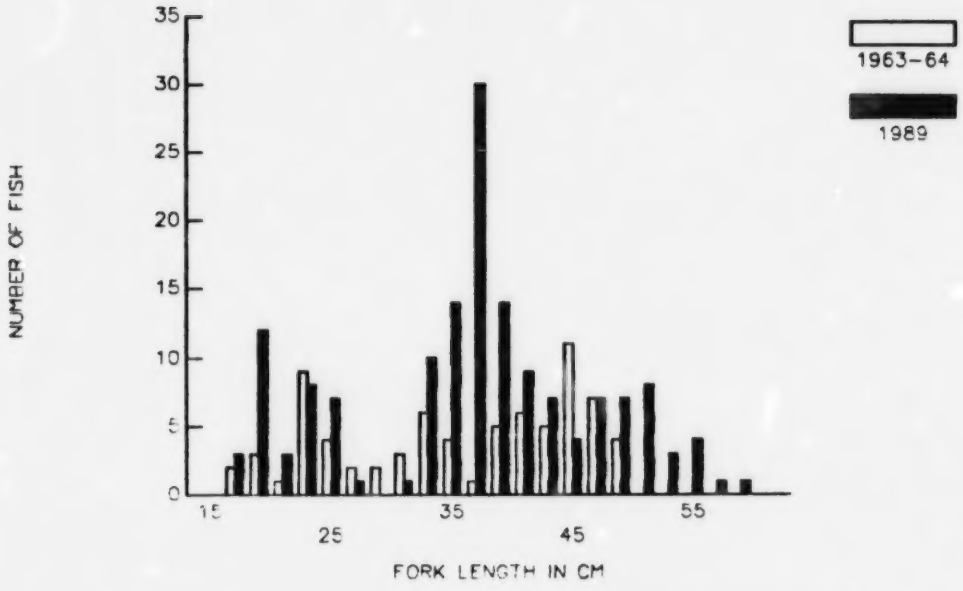

Fig. 11. Length frequency distribution of walleye caught in 10 gillnet sets in Jan Lake in 1963-64 and 1989.

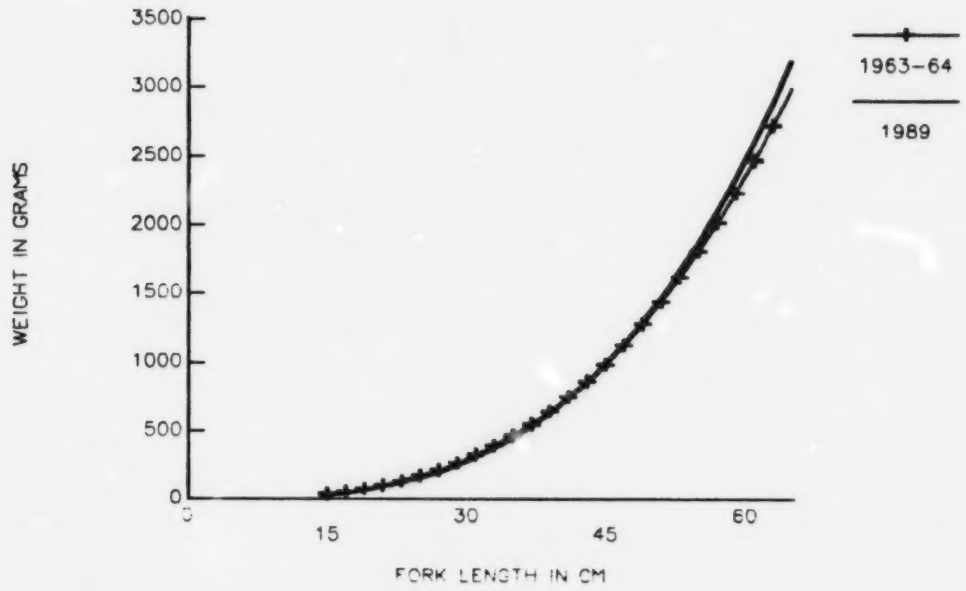

Fig. 12. Weight-length relationships of walleye caught in 10 gillnet sets in Jan Lake in 1989 (n=154) and 1963-64 (n=75). (1989: $W=0.005487*L^{3.179647}$; 1963-64: $W=0.010511*L^{3.008797}$).

Walleye ages were determined using scales in both 1989 and 1963-64. Age composition and growth of walleye are shown in Fig. 13. In the current study, 149 fish were aged. Ages ranged from 1-12 years with 80% of the catch no older than 7 years. Age classes 4-6 were the most highly represented. In 1963-64, 55 fish were aged. Estimates ranged from 1-13 years of age with the number of 3 and 5 year olds only slightly dominating the catch.

The growth curve for the current population of walleye in Jan Lake indicates a period of rapid growth in the first 2 years of life. Older fish exhibited a rate of growth slightly slower than the 1963-64 population, and up to 7 years of age, had a longer fork length at age. The observed differences in growth patterns between years are small, probably resulting from differences in sample sizes. The larger sample from the current study provides a more accurate description but supports the results from the earlier study.

The sex ratio of walleye in Jan Lake is approximately 1:1. All males younger than 4 years of age were sexually immature (Appendix 4). All those older than 7 years were mature, and only 29% of the 7 year olds were immature.

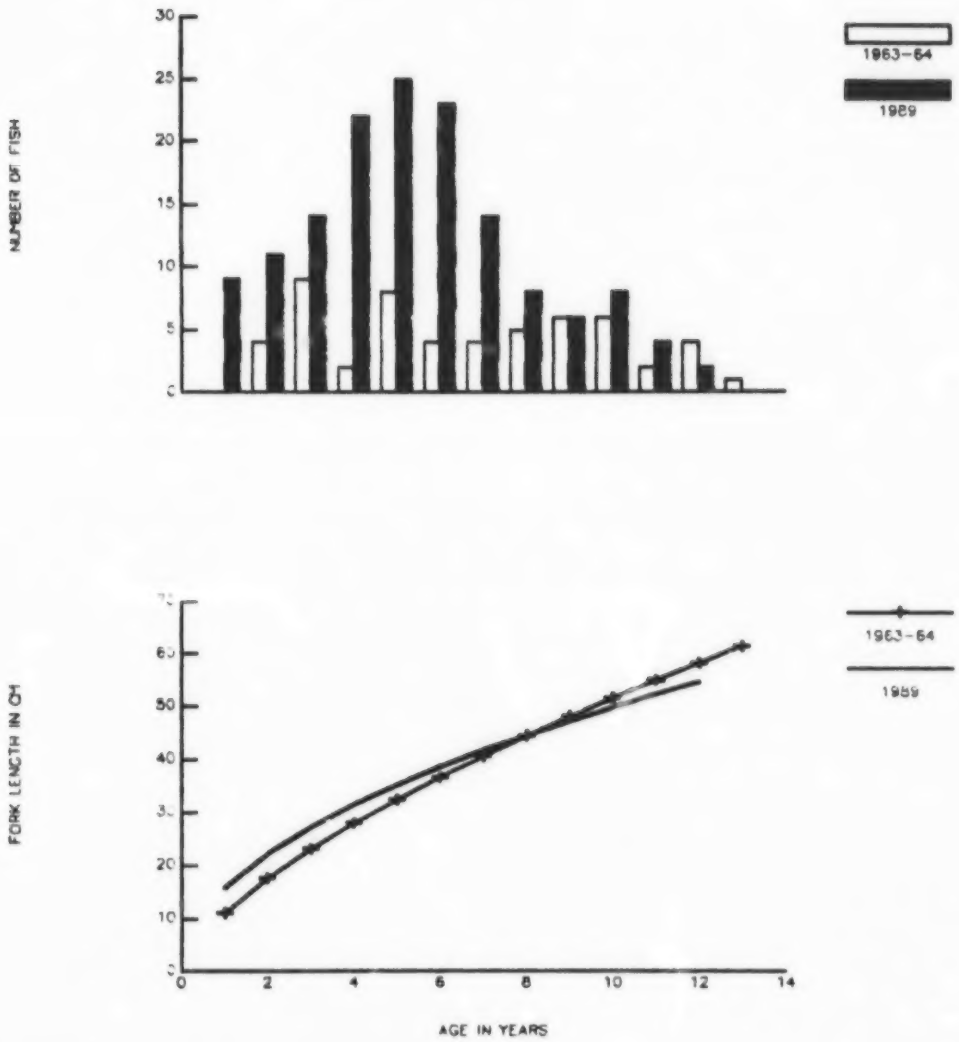

Fig. 13. Age distribution and growth of walleye caught in 10 gillnet sets in Jan Lake in 1989 (n=149) and 1963-64 (n=55).

All females younger than 6 years of age were immature and older than 7 years were mature. The data suggest that in this population the majority of males achieve sexual maturity by age 7 and an average fork length of 41 cm, while females become mature no later than age 8 with an average fork length of 46 cm.

A qualitative examination of walleye stomachs in 1989, revealed that 48% of the stomachs were empty. In 80 stomachs containing foodstuffs, fish remains (51% occurrence) and insects (49% occurrence; primarily stoneflies) were the primary constituents. In 1963-64, over 70% of food items selected by walleye were fish (Johnson, 1967).

CISCO

The total number of ciscoes caught in gill nets in 1989 was less than that caught in 1963-64. The majority of the fish (74%) were caught in the 5.1 cm and 7.6 cm meshes. In the earlier study, the 10.1 cm mesh also made a significant contribution to the total catch reflecting size differences in the fish between years.

In general, ciscoes caught in the present study were smaller than their 1963-64 counterparts. In the earlier study, the maximum fork length was 39.4 cm with an average of 26.7 cm (Table 3). The maximum fork length in the current study, was 37.3 cm and the average was 24.7 cm. The mean weight of ciscoes found in the 1963-64 study was approximately 110 g heavier than that of the same species caught in 1989.

YELLOW PERCH

The yellow perch population of Jan Lake does not appear to have increased significantly since 1963-64. Total numbers caught were similar in 1963-64 and 1989 (Table 2). The greatest number of perch were caught in the 3.8 cm mesh (over 100 fish in both studies) and the 5.1 cm mesh only. The low representation of perch in the gill nets probably reflects a preference for shallower water.

Size ranges were also similar between years. Fork lengths ranged from 11.7 cm to 21.3 cm, with an average of 14.8 cm in the earlier study (Table 3). The smallest captured in 1989 had a fork length of 12.7 cm and the largest fork length was 21.0 cm with an average of 15.1 cm.

UTILIZATION OF THE FISHERY RESOURCE

Commercial fishing on Jan Lake dates back to 1930. The earliest available quota records only go back to 1941. At that time, the quota was 22 700 kg and included lake whitefish, walleye, and lake trout. Over the next 25 years, the commercial quota fluctuated several times, reaching a maximum of 45 400 kg in 1958. In 1968, the quota was reduced to a low of 9100 kg and included whitefish only. Three years later, walleye, pike, and trout were reinstated in the quota with the proviso that these gamefish species comprise no more than 10% of the total catch.

Restrictions on mesh size were first introduced in 1953. At that time 12.7 cm mesh was legal for catching lake trout and whitefish; 11.4 cm was legal for walleye. In 1962, 12.7 cm became the legal size for all catchable species. This was reduced to 11.4 cm in 1965 to facilitate a better harvest of the mature population. The legal commercial mesh size has remained unchanged since that time.

The number of commercial licenses issued annually since 1930 has varied from 1 to 30. In the earlier years of the commercial fishery (1930-1964) lake whitefish comprised up to as much as 99% of the total harvest. Under the existing lake classification program at that time, Jan Lake fish were "A" fish (i.e. the incidence of cysts of the tapeworm *Triaenophorus crassus* was less than 40 cysts/100 g) and received better prices than the more highly infested Pelican Lake "cutter" fish. Between 1952 and 1963, whitefish caught in the southern arm of Pelican Lake were sold as Jan Lake fish to improve their marketability. These records, therefore, are unreliable, not providing a true picture of the commercial fishing on Jan Lake. In 1963-64, this practice was curtailed and the subsequent whitefish harvest from Jan Lake showed a significant drop (Appendix 5). Whitefish have consistently made up over 70% of the catch, since 1968, primarily as a result of the 10% tolerance limit imposed on the gamefish species. Lake trout production was minimal from the beginning, and virtually ceased after 1944.

Average commercial production for each decade since 1930 is shown in Table 5. Recorded production peaked in the 1950's with an

Table 5. Average commercial fish production (kg x 10^3) in Jan Lake in each decade since 1930.

	Whitefish	Walleye	Trout	Pike	Other	Total	No. Licenses
1930-39	3.3	0.5	0.2	0.6	0.6	5.3	13
1940-49	6.6	4.9	0.04	1.4	2.2	15.3	42
1950-59*	28.2	5.5	-	4.3	-	38.1	199
1960-69*	8.5	4.6	-	5.8	0.2	19.2	119
1970-79	4.4	0.6	-	0.3	0.03	5.4	89
1980-89	2.5	0.3	-	0.1	-	2.9	32

*Years include Pelican Lake harvest records

average annual yield of 38 100 kg as a result of the inclusion of Pelican Lake fish in the records and should be discounted. The average commercial production since 1970 was 4400 kg/yr comprised of 84% whitefish, 10% walleye, and 6% northern pike. In 1989, only 1 commercial license was issued and total production yielded 2790 kg (0.25 kg/ha). Lake whitefish comprised 81% of the harvest, with walleye and pike making up 12% and 7% respectively. Reasons as to why the commercial whitefish fishery is not being fully utilized may stem from current economic trends.

Records of total Indian harvest are available for 1984 to 1989 (Appendix 6). Over this 5 year period, the fishery reportedly harvested an estimated 0.04 kg/ha/yr: 29% whitefish, 2% lake trout, 16% walleye, 5% northern pike, and 48% rough fish (ciscoes, burbot, etc.). According to Murray and Clouthier's (1986) study, these records underestimate the native harvest by a factor of 10. Subsequently, a more realistic estimate of harvest between 1984 and 1989 may be 0.42 kg/ha/yr. The commercial fishery for the same time period produced 0.32 kg/ha/yr comprised of 88% whitefish, 9% walleye, and 3% northern pike.

Although there were no creel census data available, quantitative estimates of angler harvests of walleye and pike from 1986 to 1989 were determined by using results from gut can analyses (Walton, 1990). These analyses involved daily removal and weighing of the fish remains and indicating the proportion of the species represented in the cans (Appendix 7). Four or 5 sites were generally monitored on Jan Lake

and included the filleting sheds at the campground and most or all of the outfitters. In some years, not all stations reported, or there were months from which no data were available. This resulted in high variability in estimates of angler harvest between years. The average angler harvests of each species derived from these estimates are not truly representative of the total harvest. The years of highest production for each species may be a better indicator of harvest even though these too, are incomplete and do not account for anglers who generally fail to use the filleting sheds (i.e. cabin owners). Subsequently, the angler harvest of walleye would be 34 931 kg (3.08 kg/ha) and the harvest of pike would be 35 160 kg (3.10 kg/ha). Walton (1990) suggested that the total sport fish harvest on Jan Lake could be potentially as high as 39 000 kg of walleye (3.4 kg/ha) and 46 500 kg of pike (4.1 kg/ha). Full limits are not always taken, therefore, actual harvest values are probably lower. Using the years of highest production for each species as an estimate of average annual angler harvest on this lake is not unrealistic.

Between 1986 and 1989, estimated total yearly harvest of the Jan Lake fishery from all user groups was 78 639 kg or 6.92 kg/ha (Table 6). Combined, the commercial and Indian fisheries harvested 8400 kg comprising 11% of the total annual harvest. The recreational fishery accounted for 89% of the annual harvest (70 239 kg) which reflects the importance of Jan Lake as an angling lake.

Table 6. Average annual user harvest (kg x 10^3) of fish from Jan Lake from 1986 to 1989.

User	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total
Commercial	3.18	0.34	-	0.11	-	3.63
Indian	1.36	0.80	0.11	0.23	2.27	4.77
Angler	-	35.0	-	35.23	-	70.23
Total	4.54	36.14	0.11	35.57	2.27	78.63

5. DISCUSSION

FISH POPULATIONS

Seven species of fish were caught in gill nets in Jan Lake both in 1989 and 1963-64. These included, in order of abundance, common white sucker, cisco, lake whitefish, northern pike, burbot, yellow perch, and walleye; all of which are typical of Precambrian lakes. Lake trout were alluded to in the earlier study but were not present in the gill net catches. This species has not been reported in the Jan Lake commercial harvest since 1962-63 and is not believed to be currently present in the lake.

Numbers of fish collected per net set increased since the earlier survey, and total gamefish (i.e. walleye and northern pike) abundance increased, on average, by 13 fish per net set. However, compared to other Saskatchewan water bodies, such as Montreal Lake (90 gamefish/net; Merkowsky and Sawchyn, 1988), Tobin Lake (70.6 gamefish/net; Durbin, 1981), and Jackfish Lake (47.3 gamefish/net; Durbin 1980), Jan Lake (36 gamefish/net) is low in gamefish abundance. According to Johnson (1967), 65% of the water area and 84% of the water volume of Jan Lake are in depths less than or equal to 10 m. Only 2 of the 10 nets in the study were set in this depth range, and because pike and walleye generally prefer these depths, the net catches probably underestimate the abundance of these two species.

Northern pike was the more abundant of the two resident gamefish species, and the most abundant economically important species in Jan Lake. Compared to other lakes in the province, the average catch of pike per net set suggests a moderate abundance of this species:

Waterbody	No. of Pike/net set	Source
Montreal L.	40	Merkowsky and Sawchyn 1988
Pinehouse L.	23	Liaw 1988
Jan L.	21	present study
Guilloux L.	19	Liaw 1986
Dore L.	6	Sawchyn 1987

The observed differences in the age structure of the populations between years may be attributed to using different media (i.e. calcified tissue versus scales) for age determination (Weatherley and Gill, 1987). However, age estimates made from scale and cleithra collected in 1989, were similar. The presence of numerous age classes in the current population suggests that pike reproduction and recruitment has been more successful in the last few years than it was in the years preceeding the 1963-64 study.

The current population of pike grow at a slower rate than the 1963-64 population and this is a reflection of the increase in numbers and competition for food and space between years. The growth rate is similar to the growth rates observed for the same species in more southern areas such as Montreal Lake (Merkowsky and Sawchyn, 1988), and Pinehouse Lake (Liaw 1988). The growth rate of northern pike in Jan

Lake is significantly faster than that of populations found in lakes in the same geographic region (Liaw 1986).

Walleye was the least abundant economically significant species in Jan Lake in 1989. When compared on a catch per net basis to other lakes in the province, Jan Lake has a relatively low abundance of walleye:

Waterbody	No. of Walleye/net set	Source
Montreal L.	50	Merkowsky and Sawchyn 1988
Pinehouse L.	48	Liaw 1988
Guilloux L.	45	Liaw 1986
Jan L.	15	present study
Dore L.	1	Sawchyn 1987

The growth of the current population is slow when compared to the heavily exploited population of Dore Lake (Sawchyn, 1987), but is similar to the growth rate observed for the more lightly fished population from Montreal Lake (Merkowsky and Sawchyn, 1988).

An abundance of several age classes of walleye in Jan Lake is indicative of successful reproduction and good recruitment in the years preceeding the study.

The lake whitefish population showed a significant increase since 1963-64 and compared to other lakes in the province, the average catch of whitefish per net set suggests a relatively high abundance of this species:

Water body	No.of Whitefish/set	Source
Guilloux L.	42.0	Liaw 1986
Jan L.	18.9	present study
Pinehouse L.	17.2	Liaw 1988
Dore L.	15.2	Sawchyn 1987
Delaronde L.	9.9	Liaw 1976
Montreal L.	9.0	Merkowsky and Sawchyn 1988

The growth rate of Jan Lake whitefish is relatively slow when compared to other populations such as those found in Montreal Lake (Merkowsky and Sawchyn, 1988) and Pinehouse Lake (Liaw, 1988). The large proportion of older fish, high mean age and the relatively late age at maturation suggest that whitefish in Jan Lake are not being heavily exploited.

The health of a population of forage fish can be an index to the health of resident gamefish populations. Ciscoes and yellow perch, while not economically significant, are important forage species, particularly cisco.

Johnson (1967) reported that age determination of ciscoes in Jan Lake revealed abnormal variations in growth and suggested the presence of more than one species. In the current study, small mature fish and large immature fish were often observed, lending support to Johnson's conclusion.

The low representation of yellow perch in the gillnets probably reflects a preference for shoreline habitat. The sampling of small fish by seine net in 1963-64 indicated that yellow perch were

abundant in the littoral zone of Jan lake, comprising over 80% of the fish collected (Johnson, 1967).

LAKE PRODUCTIVITY

The determination of potential fish yield within a lake is necessary for the successful management of the utilization of the resource. The most highly recognized estimator of potential fish yield is the morphoedaphic index (Ryder et al., 1974). This index (MEI) was originally described as a general method of calculating fish yields from north-temperate lakes and is defined as the ratio of total dissolved solids (TDS) and mean depth (z) (Ryder, 1965). Recently, other models have been developed, incorporating factors more closely related to fish productivity in a functional sense. Two of these models include macro benthos biomass (wet weight) in relation to mean depth (Hanson and Leggett, 1965) and the standing crop of bottom fauna (dry weight) (Matuszek, 1978). Estimates of potential maximum sustainable yield (MSY) from Jan Lake were calculated from the three models shown below using data obtained from Johnson (1967):

Model[1]	MSY kg/ha/yr	kg/yr
Total, $Y=0.966\sqrt{MEI}$ (Ryder, 1965)	3.32	37 371
Total, $0.007M+0.018TDS-0.053z$ $+0.00007A_o+ 0.793$ (r^2=0.66 Hanson and Leggett, 1982)	2.67	30 341
Total, $C_t/A=-0.5524+4.9307\log BFWT$ (r^2= 0.828, Matuszek, 1978)	4.38	49 774

[1]MEI=morphoedaphic index, TDS/z; M=wet weight of bottom fauna, 83.32 kg/ha; TDS=total dissolved solids, 95 mg/L; z=mean depth, 8.0 m; A_o=water area, 113.65 km^2; C_t/A, Y=total sustainable yield; BFWT=dry weight of bottom fauna, 10.0 kg/ha.

A comparison of the potential yields reveals that all three methods gave similar estimates. However, the predictive power of the MEI has come under scrutiny in the last few years. Matuszek (1978) reported that macro benthos standing crop was a much stronger index of fish productivity, accounting for up to 82.8% of the variability in the total fish yield, while the model proposed by Hanson and Leggett (1982) using macro benthos biomass explained 66% of the variation in the total fish yield.

Because it incorporates biotic elements and explains the greatest amount of the variation in total fish yield, the model proposed by Matuszek (1978) was accepted as the best indicator of potential fish yield. Thus, the potential maximum sustainable for all fish species from Jan Lake was 4.38 kg/ha/yr or 27 844 kg/yr. This is comparable to estimates of maximum sustainable yield for other lakes in the region (Liaw, 1986).

Sustained yields of highly valued species (walleye, whitefish, and pike) are given below and were determined from MSY using the percent composition by weight in the total gillnet catch for 1989 (from Table 3). Eight of the 10 net sets were set in depths preferred by whitefish and the numbers caught probably are representative of the population. Since only 2 of the test nets were set in depths preferred by walleye and pike, it is safe to assume that numbers of these species caught underestimate their actual abundance. To account for this, the weights given in Table 2 were increased by a factor of 0.8. The resulting percent composition by weight for these species were accepted as more realistic indices of abundance and were used in determining the following.

Species	% catch by wt.	Est. yield kg/ha/yr	Est yield kg/yr
Walleye	9.0	0.3	4 432
Pike	45.0	1.97	22 387
Whitefish	15.0	0.66	7500
Total	69.0	3.02	34 319
Total highly valued species, $\log C_s/A = -0.169 + 0.562 \log BFWT$[1] ($r^2$=.803, Matuszek, 1978)		2.45	27 844

[1] C_s/a=sustainable yield of highly valued species; BFWT=dry weight of bottom fauna, 10.0 kg/ha.

The estimated total yield of walleye, pike and whitefish (3.05 kg/ha/yr) is greater than that suggested by Matuszek's (1978) equation (2.45 kg/ha/yr). Walleye, whitefish, trout, and sauger were included in the original definition of "highly valued species". Differences in this definition may explain the variation in estimates. Estimated yields for walleye and whitefish in Jan Lake were similar to a range of estimated yields from other lakes in the same geographic region (from Liaw, 1986); the yield for pike was higher:

Lake	Maximum sustainable yield, kg/ha/yr		
	Walleye	Pike	Whitefish
Jan	0.39	1.97	0.66
Guilloux	0.24-0.92	0.19-0.63	0.58-0.92
Pikoo	0.72-.079	0.60-0.66	0.88-1.37
Reeds	0.50-0.85	0.41-0.70	0.75-1.10
Sokatisewin	0.36-0.70	0.29-0.58	0.66-0.94

MANAGEMENT IMPLICATIONS

A comparison of total harvest records from the last 6 years (6.92 kg/ha/yr) and the estimated maximum sustainable yield (MSY) (4.38 kg/ha/yr) indicates that Jan Lake provides a level of production well above the estimated sustained yield. Over the last ten years, lake whitefish harvests (4400 kg/yr) have been well below the MSY (7500 kg/yr) for this species, and the characteristics of the population, including reduced growth rate, late maturation, and an

increase in the number of older and larger fish present, are a reflection of this. In contrast, based on the maximum sustainable yields for walleye (4400 kg/yr) and pike (22 400 kg/yr), these two species have been heavily overexploited for at least the last 6 years. This study has found, however, that contrary to showing signs of depletion, walleye and pike stocks appear strong and healthy; both populations are represented by a variety of age classes, and growth rates and age at maturation are moderate.

This study found that basing management decisions upon maximum sustainable yields derived from standard predictive models is not adequate for the Jan Lake fishery. Commercial harvest records, alone, could not be used because the recreational fishery has a far greater impact on the gamefish species. Recommendations from this study are based on a comparison of the actual total harvest records, the standard calculated MSY, and the population data derived from the test nets.

6. SUMMARY AND CONCLUSIONS

1. A fishery survey was undertaken in Jan Lake to evaluate the status of the resource and compare it to the results found in an earlier study conducted in 1963-64.
2. Jan Lake is situated in northeastern Saskatchewan about 80 km west of Flin Flon. Situated near the southern edge of the Precambrian

Shield, it has an area of approximately 11 400 hectares. Average water depth is 8 m with a maximum depth of 32.5 m.

3. A cottage development, 4 licensed outfitters, 4 campgrounds, and 1 motel currently rely upon the fishery resource in the lake.
4. Seven species of fish, caught in 10 standard gangs of gillnet were the same as those caught in an earlier study. Numbers of each species caught per net set indicate an increase in fish populations between years.
5. Ciscoes were the most abundant species in the gillnet catches, followed by common white sucker. These 2 fish species comprised 55% of the total catch. Perch and burbot were the least abundant and made up 11% of the total catch.
6. Northern pike was the most abundant highly valued species, followed by lake whitefish and walleye. Collectively, these three species made up 34% of the total gillnet catch.
7. Northern pike ranged in size from 26.0 cm to 83.8 cm but the majority were between 50-60 cm in length and weighed over 1 kg. Over 50% of the fish were 4-5 years of age. Fish in the current population exhibited a slower rate of growth than those from the earlier study. A variety of fish species contributed to the diet of pike.
8. The majority of walleye caught were larger than 35 cm in fork length, and were 4-6 years of age. The presence of numerous year classes, a high proportion of young fish and a relatively late age

at maturation indicate a healthy walleye population in Jan Lake. Fish and insects were consumed by walleye at about equal frequency.

9. The majority of lake whitefish caught were over 35 cm in fork length and weighed more than 0.5 kg. Only 8% of the aged specimens were younger than 5 years of age, while 70% were in the 6-8 year age class. The growth rates of lake whitefish were similar between years. Sexual maturity occurred between 5-6 years of age. Chironomid larvae were the major dietary item of whitefish.
10. Evidence suggests there are two populations of cisco currently inhabiting Jan Lake.
11. The yellow perch population has not changed significantly since 1963-64.
12. Commercial fishing records for Jan Lake are available since 1930, but are not reliable prior to 1964.
13. The commercial quota is currently 9100 kg with a 10% tolerance limit on walleye, pike, and trout. Average annual production since 1970 is 4400 kg comprised of 84% whitefish, 10% walleye, and 6% pike.
14. Average annual Indian harvest since 1986 was estimated at 0.42 kg/ha (4800 kg), comprised of 25% each of lake whitefish and walleye, and 50% other species (cisco, burbot, perch).
15. Angler harvest from 1986 to 1989 was estimated to be 6.18 kg/ha/yr, (70 230 kg/yr) comprised of 50% walleye and 50% northern pike.
16. Macrobenthos standing crop was used to estimate the fish yield in Jan Lake. The maximum sustainable yield of all species was

estimated at 4.38 kg/ha/yr and at 3.02 kg/ha/yr for highly valued species.

17. A comparison of actual harvest data with the estimated sustainable yield indicates that lake whitefish are underutilized, while both northern pike and walleye are severely overutilized. Population data suggest that while the former is true, MSY estimates for walleye and pike are too low to be able to sustain current harvest levels.

RECOMMENDATIONS

1. Encourage the growth of the commercial whitefish fishery on Jan Lake.
2. Retention of the current commercial quota of 9100 kg, with a 10% tolerance limit on gamefish species. As this quota is not being met, changes to it will not have any significant effect in the fishery.
3. Retention of the current legal mesh size of 11.4 cm.
4. Annual recreational harvest limits of walleye and pike should not exceed 35 000 kg for each. This is the current level of pressure being exerted and both populations appear strong.
5. Changes in the structure of the resident fish populations should be monitored by regular reassessments at 5 year intervals.
6. Future lake monitoring studies should make an attempt to adequately sample all depth zones within the lake.

7. Some measure of sustainable yield must be developed, whether it be based upon geological, regional, or morphometric characteristics of a lake, so that a standard exists for lakes throughout the province.

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Appendix 1. Total number of fish and average length (centimeters) of fish caught per gillnet set in Jan Lake in 1989. (mean depth in meters)

Net Set	Mean Depth	Whitefish		Walleye		Pike		Cisco		Perch		CWSucker		Burbot	
		No.	Length	No.	Length	No.	Length	No.	Length	No.	Length	No.	Length	No.	Length
1	11.5	4	38.9	3	48.5	28	59.6	89	18.3	12	12.7	23	27.5	4	59.3
2	12	1	34.8	50	33.9	15	52.5	46	16.5	22	10.2	30	28	4	57.7
3	6.3	3	35.7	54	33.2	38	53.1	37	25.8	42	15.2	83	38	0	-
4	14.5	14	36.8	3	38.2	21	57.4	53	23.4	10	14.9	16	35.4	5	59.8
5	13	5	39.6	9	39.7	38	56.9	63	27.9	31	14.6	34	38.1	1	62.7
6	23.5	65	39.3	1	47.4	6	62.9	90	18.1	0	-	0	-	0	-
7	19.5	0	-	0	-	0	-	0	-	0	-	0	-	0	-
8	14	56	44.9	4	52.8	15	58.1	65	19.3	0	-	21	31.4	3	57.6
9	8	0	-	25	35.6	31	45.1	0	-	48	15.4	79	24.6	0	-
10	21.5	41	41.5	5	51.8	14	60.6	162	18	0	-	0	0	0	-
Total		189	-	154	-	206	-	605	-	165	-	286	-	17	-

Appendix 2. Age and state of maturity of lake whitefish caught in gill nets in Jan Lake in 1989.

Age (y)	Male		Female	
	Mature	Immature	Mature	Immature
1	0	0	0	0
2	0	1	0	0
3	0	1	1	2
4	2	1	2	2
5	8	1	4	1
6	20	0	12	0
7	29	0	20	0
8	20	0	21	0
9	9	0	11	0
10	2	0	1	0
11	0	0	1	0
12	0	0	1	0

Appendix 3. Age and state of maturity of northern pike caught in gill nets in Jan Lake in 1989.

Age (y)	Male		Female	
	Mature	Immature	Mature	Immature
1	0	2	0	2
2	0	0	2	1
3	11	0	19	0
4	26	0	23	0
5	26	0	19	0
6	10	0	16	0
7	8	0	9	0
8	4	0	3	0
9	1	0	0	0
10	1	0	1	0

Appendix 4. Age and state of maturity of walleye caught in gill nets in Jan Lake in 1989.

Age (y)	Male		Female	
	Mature	Immature	Mature	Immature
1	0	1	0	7
2	0	1	0	6
3	0	6	0	8
4	2	7	0	10
5	1	13	0	13
6	3	9	1	10
7	6	2	5	4
8	6	0	4	0
9	2	0	5	0
10	5	0	3	0
11	2	0	2	0
12	2	0	0	0

Appendix 5. History of the commercial fishery production of Jan Lake from 1948 to 1989 inclusive (weight in kilograms).

Year	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total	No. Licenses
1930-31	12247	1678	771	363	2722	17781	7
1931-38	no fishing						
1938-39	10238	1687	454	1134	2268	15781	3
1939-40	10923	1270	508	4928	1814	19443	3
1940-41	15559	1248	284	2223	8165	27479	3
1941-42	7455	2259	32	3265	4132	17143	3
1942-43	9547	4122	0	928	2473	17070	5
1943-44	18604	4208	81	7896	7630	38419	7
1944-45	no fishing						
1945-46	15720	143	0	0	-	15863	7
1946-48	no fishing						
1948-49	0	21872	0	0	-	21872	6
1949-50	0	15338	0	0	-	15338	11
1950-51	4478	7639	0	0	-	12117	11
1951-52	22900	3225	0	3967	-	30092	19
1952-53	32752	1948	8	2556	-	37264	20
1953-54	29973	6531	0	2096	-	38600	18
1954-55	25851	0	11	3681	-	29543	21
1955-56	31582	10101	0	6790	-	48473	25
1956-57	41703	7225	9	4664	-	53601	30
1957-58	31115	5671	0	4478	-	41264	19
1958-59	27223	4859	0	6244	-	38326	20
1959-60	34394	8113	0	8865	-	51372	16
1960-61	23325	9798	0	11125	-	44248	15
1961-62	24831	13486	0	16129	-	54446	17
1962-63	23562	10609	2	18024	-	52197	27
1963-64	2034	2308	-	2100	-	6442	22
1964-65	no fishing						
1965-66	2985	2504	-	1504	-	6993	11
1966-67	757	1747	-	665	-	3169	6
1967-68	1794	5260	-	7881	2773	17708	9
1968-69	1397	177	-	111	-	1685	4
1969-70	4775	322	-	491	-	5588	8
1970-71	7904	946	-	764	-	9614	13
1971-72	6253	257	-	185	-	6695	12
1972-73	4258	494	-	216	-	4968	9
1973-74	3180	888	-	337	-	4405	11
1974-75	4555	435	-	227	-	5217	4

Appendix 5. History of the commercial fishery production of Jan Lake from 1948 to 1989 inclusive (weight in kilograms). (continued)

Year	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total	No. Licenses
1975-76	6624	1630	-	924	271	9449	8
1976-77	3901	494	-	289	-	4684	13
1977-78	3556	518	-	338	-	4412	9
1978-79	1863	181	-	118	-	2162	4
1979-80	2520	202	-	0	-	2722	6
1980-81	1529	358	-	114	-	2001	3
1981-82	184	19	-	15	-	218	1
1982-83	4139	160	-	175	-	4474	6
1983-84	0	0	-	0	-	0	1
1984-85	2052	83	-	22	-	2157	4
1985-86	4161	523	-	89	-	4773	6
1986-87	7480	735	-	268	-	8483	4
1987-88	3231	305	-	304	-	3840	6
1988-89	2259	324	-	207	-	2790	1
Total	537373	163900	2160	126700	32248	862381	494
% total	62.3	19.0	0.2	14.7	3.7	100.0	
Average	8956.2	2731.7	36.0	2111.7	537.5	14373.0	
kg/ha/yr	0.79	0.24	0	0.19	0.05	1.29	

Appendix 6. History of the Indian harvest (in kg) in Jan Lake between 1984 and 1989.

Year	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total
1984-85	150	10	0	20	30	210
1985-86	45	10	0	10	60	125
1986-87	0	300	50	0	400	750
1987-88	300	25	0	50	100	475
1988-89	200	40	0	50	550	840
Total	695	385	50	130	1140	2400
% total	28.9	16.0	2.0	5.4	47.4	
Average	139	77	10	26	228	480
kg/ha/yr	0.01	0.01	-	-	0.02	0.04

Appendix 7. History of the summer angler harvest (kg) in Jan Lake from 1986 to 1989. (from Walton, 1990)

Year	Walleye	Trout	Northern Pike	Total
1986	4637	0	4194	8831
1987	34931	0	20324	55255
1988	15180	0	35160	50340
1989	11252	0	8402	19654
Total	66000	0	68080	134080